

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1. (Cancelled)

Claim 2. (Currently Amended) An apparatus for supporting a biofilm in a liquid comprising:

a) a plurality of gas permeable hollow fibers, each hollow fiber having a lumen, an outer surface, a first open end and ~~The apparatus of claim 1 wherein the hollow fibers have an outside diameter of 100 microns or less; and,~~

b) a header, the header having a cavity and a port open to the cavity, wherein the hollow fibers extend from the header, with the outer surfaces of the open ends of the hollow fibers sealed to the header and the lumens of the hollow fibers communicating with the port through the cavity.

Claim 3. (Currently Amended) The apparatus of claim 4 2 wherein the hollow fibers have a hollow area of 10% of the cross-sectional area of the hollow fibers or more, more preferably 30% of the cross-sectional area of the hollow fibers or more.

Claim 4. (Currently Amended) The apparatus of claim 4 2 wherein the hollow area is 50% of the cross-sectional area of the hollow fibers or less.

Claim 5. (Currently Amended) An apparatus for supporting a biofilm in a liquid comprising:

a) a plurality of gas permeable hollow fibers, each hollow fiber having a lumen, an outer surface, a first open end, The apparatus of claim 1 wherein the hollow fibers are non-porous or dense walled; and,

b) a header, the header having a cavity and a port open to the cavity, wherein the hollow fibers extend from the header, with the outer surfaces of the open ends of the hollow fibers sealed to the header and the lumens of the hollow fibers communicating with the port through the cavity.

Claim 6. (Currently Amended) The apparatus of claim 4 5 wherein the hollow fibers comprise polymethyl pentene.

Claim 7. (Currently Amended) The apparatus of claim 4 2 wherein the hollow fibers have a second end and are between 0.25 metres and 3.0 metres long.

Claim 8. (Original) The apparatus of claim 7 wherein the hollow fibers have a second end and are between 1.0 metres and 2.0 metres long.

Claim 9. (Currently Amended) An apparatus for supporting a biofilm in a liquid comprising:

a) a plurality of gas permeable hollow fibers, each hollow fiber having a lumen, an outer surface, a first open end, The apparatus of claim 1 wherein the hollow fibers are having an outside diameter of 500 microns or less and being arranged into two or more groups of fibers; and,

b) a header, the header having a cavity and a port open to the cavity, wherein the hollow fibers extend from the header, with the outer surfaces of the open ends of the hollow fibers sealed to the header and the lumens of the hollow fibers communicating with the port through the cavity.

Claim 10. (Currently Amended) The apparatus of claim 9 wherein the each of the groups of fibers comprises between 24 and 96 hollow fibers.

Claim 11. (Currently Amended) The apparatus of claim 9 wherein the each of the groups of fibers further comprises second fibers that are stronger than the hollow fibers.

Claim 12. (Currently Amended) The apparatus of claim 9 wherein the at least one of the groups is a tow of fibers.

Claim 13. (Currently Amended) The apparatus of claim 9 wherein the at least one of the groups is a thread, yarn or twisted fibers.

Claim 14. (Currently Amended) The apparatus of claim 4 9 wherein the hollow fibers are curled, crimped or undulating along their length.

Claim 15. (Cancelled)

Claim 16. (Currently Amended) ~~The apparatus of claim 15 further comprising~~ An apparatus for supporting a biofilm in a liquid comprising:

a) a plurality of gas permeable hollow fibers, each hollow fiber having a lumen, an outer surface, a first open end, the hollow fibers extending along their length generally in a first direction;

b) a header, the header having a cavity and a port open to the cavity, wherein the hollow fibers extend from the header, with the outer surfaces of the open ends of the hollow fibers sealed to the header and the lumens of the hollow fibers communicating with the port through the cavity; and,

c) third fibers extending along their length generally in a second direction, the second perpendicular to the first direction.

Claim 17. (Original) The apparatus of claim 16 wherein the third fibers and hollow fibers are intertwined.

Claim 18. (Original) The apparatus of claim 17 wherein the hollow fibers and third fibers form a fabric.

Claim 19. (Original) The apparatus of claim 18 wherein the fabric is generally continuous across the length of the hollow fibers.

Claim 20. (Original) The apparatus of claim 18 wherein the fabric extends over a portion of the length of the hollow fibers near their open ends and does not extend over a central portion of the length of the fibers.

Claim 21. (Original) The apparatus of claim 20 wherein the hollow fibers and third fibers are woven, knitted, stitched or warp knitted together over at least a portion of the length of the hollow fibers.

Claim 22. (Currently Amended) An apparatus for supporting a biofilm in a liquid comprising:

a) a plurality of gas permeable hollow fibers, each hollow fiber having a lumen, an outer surface, a first open end, a ~~The apparatus of claim 1 wherein the hollow fibers have~~ second open ends; and,

b) a first header, the first header having a cavity and a port open to the cavity, wherein the hollow fibers extend from the first header, with the outer surfaces of the open ends of the hollow fibers sealed to the first header and the lumens of the hollow fibers communicating with the port through the cavity.

Claim 23. (Original) The apparatus of claim 22 wherein the second open ends of the hollow fibers are potted in a second header.

Claim 24. (Original) The apparatus of claim 23 wherein the second open ends communicate with a second port of the second header through a second cavity of the second header.

Claim 25. (Currently Amended) The apparatus of claim 23 wherein the first header and the second header are spaced apart from each other and the hollow fibers are arranged into one or more flat sheets or generally parallel planar structures extending between the headers.

Claim 26. (Original) The apparatus of claim 25 wherein the flat sheets or planar structures are generally parallel to each other.

Claim 27. (Original) One or more of the apparatus of claim 25 wherein adjacent planar structures have a spacing between them of between 2 mm and 20 mm or, more preferably, of between 3 mm and 15 mm.

Claim 28. (Original) The apparatus of claim 23 wherein the first header and second header are held apart at a distance that applies a tensile force to the hollow fibers.

Claim 29. (Original) The apparatus of claim 25 further comprising spacers between the flat sheets or planar elements outside of the header.

Claim 30. (Original) The apparatus of claim 25 wherein the flat sheets or planar structures further comprise a rigid member extending between the headers.

Claim 31. (Currently Amended) An apparatus for supporting a biofilm in a liquid comprising:

a) a plurality of gas permeable hollow fibers, each hollow fiber having a lumen, an outer surface, a first open end; and,

b) a header, the header having a cavity and a port open to the cavity, wherein the hollow fibers extend from the header, with the outer surfaces of the open ends of the hollow fibers sealed to the header and the lumens of the hollow fibers communicating with the port through the cavity, and wherein the apparatus has ~~The~~

~~apparatus of claim 1~~ having a surface area for oxygen transfer to surface area of supported biofilm ratio of about 1.6 or more.

Claim 32. (Original) The apparatus of claim 31 having a surface area for oxygen transfer to surface area of supported biofilm ratio of about 2 or more.

Claim 33. (Original) The apparatus of claim 32 having a surface area for oxygen transfer to surface area of supported biofilm ratio of about 5 or more.

Claim 34. (Original) The apparatus of claim 33 having a surface area for oxygen transfer to surface area of supported biofilm ratio of about 1 or less.

Claim 35. (Original) The apparatus of claim 18 wherein the roughness of the fabric is between 0.1 and 2 mm.

Claim 36. (Currently Amended) A reactor comprising:

- a) a tank for holding a liquid to be treated, the tank having an inlet and an outlet;
- b) an apparatus ~~according to claim 1~~ for supporting a biofilm in a liquid comprising:
 - i). a plurality of gas permeable hollow fibers, each hollow fiber having a lumen, an outer surface, a first open end, and
 - ii). a header, the header having a cavity and a port open to the cavity, wherein the hollow fibers extend from the header, with the outer surfaces of the open ends of the hollow fibers sealed to the header and the lumens of the hollow fibers communicating with the port through the cavity; and
- c) a gas delivery system for providing a gas to the port.

Claim 37. (Original) The reactor of claim 36 further comprising an agitator or aerator adapted to agitate the liquid around the apparatus.

Claim 38. (Original) The reactor of claim 36 further comprising a chemical injection system for injecting chemicals into either the lumens of the hollow fibers or a part of the reactor in communication with the outer surfaces of the hollow fibers.

Claim 39. (Original) The reactor of claim 36 having a heater to heat either the gas provided to the port or the liquid held in the tank.

Claim 40. (Original) A multi-stage reactor having two or more reactors according to claim 36, the outlet of a first reactor connected to the inlet of a second reactor.

Claim 41. (Original) The multi-stage reactor of claim 40 wherein the first and second reactors are plug flow reactors, batch reactors or continuously stirred reactors.

Claim 42. (Original) The multi-stage reactor of claim 37 wherein the apparatus of the second reactor has a lower surface area for oxygen transfer to surface area of supported biofilm ratio than the apparatus of the first reactor.

Claim 43. (Original) The multi-stage reactor of claim 40 wherein the apparatus of the first reactor has a surface area for oxygen transfer to surface area of supported biofilm ratio between of 5 or more and the apparatus of the second reactor has a surface area for oxygen transfer to surface area of supported biofilm ratio of 5 or less.

Claim 44. (Original) The reactor or multi-stage reactor of claim 36 wherein the reactor(s) have a plurality of the apparatus arranged in parallel between the inlet and outlet.

Claim 45. (Original) The multi-stage reactor of claim 40 wherein the fibers of the apparatus of the first reactor are formed into a sheet along their entire length while the

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fibers of the apparatus of the second reactor are unsupported by perpendicular fibers over a portion of their length.

Claims 46 – 87 (Cancelled)